The Effect of Hemispheric Synchronization on Intraoperative Analgesia

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In this double-blinded randomized study, we sought to confirm that patients undergoing general anesthesia who were exposed to a hemispheric synchronization (Hemi-Sync) musical recording during surgery had a smaller analgesia requirement, as was suggested in a previous study. Bispectral index monitoring was used to adjust depth of hypnosis, and hemodynamic variables were used to determine analgesia administration. Consented patients underwent either laparoscopic bariatric or one-level lumbar disk surgery. After endotracheal intubation and application of headphones, baseline heart rate and arterial blood pressure were established. Isoflurane was titrated to maintain sedation on the basis of a target bispectral index range of 40-60, and 25-jug increments of fentanyl were administered in response to increases in heart rate and systolic arterial blood pressure. Bariatric patients who listened to Hemi-Sync required one-third less fentanyl than the control group (mean [SD]: 0.015 [0.01] vs 0.024 /j,g • kg • min'[l] [0.01]) (P = 0.009). It is interesting to note that lumbar patients in the experimental and control groups required similar amounts of fentanyl (0.012 [0.01] vs 0.015 /j.g • kg [a] • min'[l] [0.01]). End-tidal isoflurane concentration was similar for Hemi-Sync and blank-tape patients (bariatric, 0.74% (0.14) vs 0.77% (0.21); lumbar, 0.36% [0.16] vs 0.39% [0.12]). The bariatric patients in this study demonstrated that Hemi-Sync may be an innovative intraoperative supplement to analgesia.

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Patients undergoing general anesthesia with paralysis are in an unconscious state but may retain their sense of hearing. To take advantage of this possibility, innovative music has recently been developed. One example (1) is a binaural beat technology known as hemispheric synchronization (Hemi-Sync), created by the Monroe Institute (Faber, VA). Hemi-Sync involves the simultaneous play of 2 tones that differ by 15 decibels in each ear, as well as positive verbal messages. Numerous Hemi-Sync recordings are available, including a six-cassette Surgical Support Series. A previous study by Kliempt et al. (1) showed that using the intraoperative tape from this series in conjunction with general anesthesia was highly effective; it decreased the amount of analgesia *oy* 78% (28 /xg of fentanyl with Hemi-Sync versus 126 u,g with a blank tape).

Kliempt et al.'s study relied only on hemodynamic signs to determine the degree of hypnosis. We used the bispectral index (BIS) to confirm that all patients were equally sedated. BIS is a processed electroencephalogram that is used to monitor anesthetic depth (degree of hypnosis) (2,3) by quantifying the amplitude and frequency of electroencephalogram waves on a scale of 0 to 98, with 0 indicating minimal brain activity and 98 indicating full consciousness (4). When the BIS is between 40 and 60, the patient is in an appropriate hypnotic state (5). The use of BIS to control titration of anesthetics has been described (6). In this study, we maintained the BIS at 50 ± 10.

Whereas the previous study included patients in a wide variety of surgical groups, this study examined the effects of listening to Hemi-Sync on two specific patient populations—lumbar laminectomy/laminotomy patients and laparoscopic bariatric patients—based on the common cases performed by the participating anesthesiologists. Within each surgical group, the experimental group Listened to Hemi-Sync and the control group listened to a blank tape. We sought to confirm the results of the study by Kliempt et al., which suggested that patients who listened to Hemi-Sync would require less

from patients undergoing lumbar spine or bariatric surgical procedures. We excluded individuals with a history of seizures, auditory impairment, or prior knowledge of the Monroe Institute.

On entering the operating room, a BIS sensor was applied to the patient, who was then given a standardized bolus of 2 mg of midazolam IV. Anesthesia was induced with propofol, and 8-10 mg of IV vecuronium was used for paralysis (bariatric patients were given 100 jug of succinylcholine to facilitate rapid-sequence induction and were given vecuronium after this). Each patient was given a standardized dose of fentanyl based on the anticipated induction dose needed for each procedure—250 /xg for bariatric patients and 100 /Ag for lumbar laminectomy/laminotomy patients. Every patient having a bariatric procedure was maintained with oxygen 1.0 L/min and air and isoflurane 1.0 L/min, and every patient having a lumbar procedure was maintained with oxygen 1.0 L/min and nitrous oxide and isoflurane 1.0 L/min. Patients were monitored with noninvasive measurement of systolic and diastolic blood pressure, five-lead electrocardiography, pulse oximetry, capnography, temperature probe, nerve stimulator, and BIS.

After endotracheal intubation, positioning, and adequate hypnosis (BIS of 50 ± 10), headphones (HP-CN5; Aiwa, San Diego, CA) were placed on the patient's ears and the tape was turned on. Patients were randomly assigned a Hemi-Sync or blank tape (UR IEC Type 1; Maxell, Fair Lawn, NJ) on the basis of a predetermined randomization for each surgical group of 30 patients and the 2 tapes. Both the anesthesiologist and the patient were blinded to the content of the tape. All tapes were played continuously at the same low-volume setting by using an autoreverse cassette player (CFD-S39; Sony, Tokyo, Japan).

No surgical stimulation was permitted for the initial 10 min after the beginning of tape play. Subsequently, isoflurane was adjusted to return the BIS to 50 ± 10, if necessary. To maintain blood pressure within safe margins, we administered labetalol or ephedrine if the systolic blood pressure was more than 160 mm Hg or less than 80 mm Hg. Once the BIS and systolic blood pressure were within these ranges, baseline heart rate and blood pressures were established for each patient. These values were used as guidelines throughout the rest of the procedure, and this time point marked the start of data collection. However, if the BIS and blood pressure were not within acceptable ranges after an additional 10 min, the patient was removed from the studv and treated accordinelv. faster than the baseline or the systolic blood pressure was 20% higher than the baseline for 5 min, 25 /ig of fentanyl was administered IV.

The study concluded at a predetermined intraoperative point before surgical closure or if a maximum fentanyl dosage was administered. In the bariatric cases, the study was concluded when the second anastomosis was sutured or when more than 1000 /xg of fentanyl (750 jag within the study period) was administered. In the lumbar spine cases, the study was concluded when the retractor was removed or when more than 500 jug of fentanyl (400 ju,g within the study period) was administered.

Fentanyl administration (jug • kg"[1] • min"[1]) was analyzed and compared separately for the two procedures by using Student's Mest. The induction bolus of fentanyl was not included in this calculation. Regression analysis was used to determine the effect of age and sex.

Results

Sixty-nine patients were asked to participate in this study. Sixty-four patients signed the consent form. Sixty participated in the study to completion. Four patients who signed the consent form did not complete the study: one voluntarily withdrew before the procedure started, two canceled their surgery, and one was withdrawn from the study, on the basis of the previously described protocol, because of continued hypotension. Thirty patients underwent laparoscopic bariatric procedures (gastric bypass or biliopancreatic diversion), and 30 patients underwent lumbar procedures (laminectomy or laminotomy). In each surgical group, 15 patients listened to Hemi-Sync and 15 listened to a blank tape.

Demographic data for each surgical group and tape group are shown in Table 1. There was no statistical difference between the mean baseline measurements for blood pressure and heart rate for all bariatric patients and all lumbar patients, respectively. Before baseline values were established, labetalol was administered to two bariatric patients and one lumbar patient, and ephedrine was administered to one bariatric patient and one lumbar patient. Intraoperative data, including average blood pressure, heart rate, BIS, end-tidal isoflurane concentration, and study length, were also statistically identical for all patients within each surgical group (Table 2). The study period ended at

Table 1. Preoperative Demographics

Procedure	Condition	*n*	Age (y)	Weight (kg)	HR (bpm)	BPS (mm Hg)	BPD (mm Hg)
Bariatric	Hemi-Sync	15	38 (10)	150 (31)	70 (12)	117 (18)	61 (12)
Bariatric	Blank tape	15	41 (10)	136 (30)	69(9)	109 (12)	63 (11)
Lumbar	Hemi-Sync	15	56 (16)	82 (14)	60 (11)	110 (17)	67(8)
Lumbar	Blank tape	15	52 (11)	87 (21)	63 (11)	109 (16)	72 (11)

Values are mean (SD).
HR = heart rate; BPS = arterial systolic blood pressure; BPD = arterial diastolic blood pressure.

Table 2. Intraoperative Demographics (Average Values for Study Period)

Procedure	Condition	*n*	HR (bpm)	BPS (mm Hg)	BPD (mm Hg)	BIS	elso (%)	Time (min)"	Fentanyl (/Ag)[fa]
Bariatric	Hemi-Sync	15	76 (10)	135 (19)	77 (10)	53(5)	0.74 (0.14)	130 (74)	298 (210)
Bariatric	Blank tape	15	75 (12)	132 (9)	79(9)	49(5)	0.77 (0.21)	136 (26)	412 (119)
Lumbar	Hemi-Sync	15	63 (12)	113 (11)	71(6)	46(5)	0.36 (0.16)	170 (61)	203 (136)
Lumbar	Blank tape	15	64(9)	113 (11)	75 (10)	48(5)	0.39 (0.12)	176 (73)	198 (167)

Values are mean (SD).
HR = heart rate; BPS = arterial systolic blood pressure; BPD = arterial diastolic blood pressure; BIS = bispectral index (BIS); elso = end-tidal isoflurane.
" Length of study period.
[b] Excludes induction dose.

Table 3. Results

Procedure	Condition		Fentanyl • kg"[1] • min"[1])	*P* value
Bariatric	Hemi-Sync	15	0.015 (0.01)	0.009
Bariatric	Blank tape	15	0.024 (0.01)	
Lumbar	Hemi-Sync	15	0.015 (0.01)	0.549
Lumbar	Blank tape	15	0.012 (0.01)	

Values are mean (SD).

Listening to Hemi-Sync resulted in the administration of one-third less fentanyl. Lumbar patients who listened to Hemi-Sync had the same fentanyl requirement as those who listened to a blank tape (0.015 [0.01] vs 0.012 /Lig • kg"[1] • min"[1] [0.01]) (Table 3). No correlation was seen between sex or age and the amount of fentanyl required for either procedure.

Discussion

Listening to Hemi-Sync may result in significantly decreased use of fentanyl in bariatric cases. It is interesting to note that lumbar patients in the experimental and control groups required similar amounts of fentanyl. This may be a fault of the methodological design of the study. Patients in the lumbar surgical group breathed nitrous oxide, itsplf augments analeesia. Perhaos the use of produced an appropriate depth of sedation with invariant hemodynamics in four lumbar patients, all of whom listened to the blank tape. As a result of this, the threshold for observing a difference in analgesia requirement for the lumbar patients may not have been apparent. Every bariatric patient required additional analgesia beyond the induction dose, with the exception of one patient who listened to Hemi-Sync. The change in position for bariatric patients from Trendelenburg to reverse Trendelenburg may have prompted additional hemodynamic changes in this surgical group. Trendelenburg positioning has been associated with increased arterial blood pressure (7). The lumbar patients were prone throughout the study period. Prone positioning has been associated with decreased fluctuation in heart rate and blood pressure (8). Additionally, the bariatric surgical procedures were laparoscopic, and insufflation can lead to an increase in arterial blood

Desflurane, which has a faster rate of onset than isoflurane, would allow for enhanced control. Isoflurane was chosen as the inhaled anesthetic in this study, however, because it is the standard anesthetic used at this institution. Remifentanil would also allow for enhanced control and could prevent the need for placing a maximum limit on fentanyl administration to ensure timely emergence. Fentanyl was used as the opioid in this study, rather than remifentanil, because of cost considerations.

This study improved on the accuracy of Kliempt et al. (1), who showed that listening to Hemi-Sync during surgery greatly decreased the analgesia requirement. The previous study reviewed patients undergoing numerous procedures and used hemodynamics alone to direct opioid administration. The analgesia requirement was reduced by 78% when patients listened to Hemi-Sync. We restricted the type of cases to two common surgical procedures and compared analgesia requirements for patients who had the same procedure. We also used BIS to ensure an equivalent depth of hypnosis in addition to using hemodynamics as a determinant of analgesia requirement. In this study, we compared fentanyl administration in micrograms per kilogram per minute, whereas Kliempt et al. compared total fentanyl administration in micrograms. These modifications to the previous study's protocol produced a more reliable and controlled study. Our results for bariatric patients showed a one-third reduction in fentanyl requirement for patients who listened to Hemi-Sync.

There is a growing public interest in the use of music as a form of natural sedation and anxiolysis. Patients who listen to music while under general anesthesia have rated themselves as more comfortable during surgery than patients who listen to nothing (10). In recovery, patients recuperate faster when they are listening to music (11). In this study, 93% of patients who were asked to participate agreed. Two of the patients who were unwilling to participate in the study brought their own headphones and music for intraoperative play. Many of the patients from both the control and experimental groups in this study, who were still blinded, requested to listen to Hemi-Sync in the recovery room.

Music is one of many potential adjuvants to traditional pharmacological analgesia. Attempts have been made to diminish pain by using acupuncture (12), massage therapy (13), guided imagery (14), hypnosis, and relaxation (15). We agree with Kliempt et al. (1) that Hemi-Sync may be a promising, novel, intraoperative supplement to analgesia. A more expansive study that covers the breadth of surgical procedures and includes patient feedback, postoperative pain scores, and the incidence of nausea and vomiting would further support this conclusion.

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